U.S. DEPARTMENT OF ENERGY

Sponsor

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A Single Substance Organic Redox Flow Battery

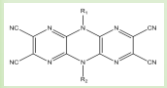
Introduction Flow Batteries are of great utility for energy storage by de-coupling energy and power.

Background The state of the art predominantly employs metallic systems, especially Vanadium. An organic active material provides a competitive, greener alternative.

Project Aim Vinazene SBIR No. DE-SC0007662 endeavors to develop an organic RFB using proprietary compounds, combining unique manufacturing and operational advantages including single substance, larger OCP and lower cost.

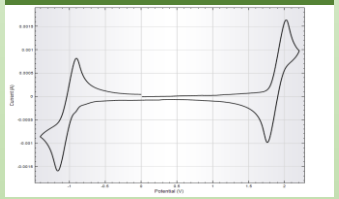
1. Rapid synthetic pathway to ~20 Compound "Z" Derivatives

The species under investigation are 2,3,6,7-tetracyano-9,10-R_1,R_2-1,4,5,8,9,10 - hexaazaanthracenes where the groups substituted at the 9,10 positions are R_1 and R_2. We call these compounds "Z" for short. The solubility and stability of Z are controlled by varying the R_1 and R_2 functionalities.

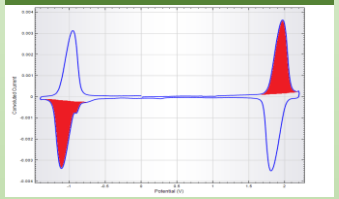


A patent, **US 8742107**, was issued to Vinazene in June 2014 for novel methods of synthesizing new Z derivatives.

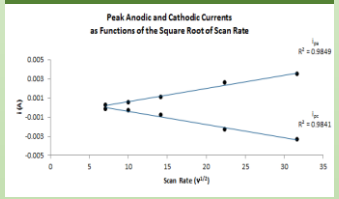
Cyclic Voltammogram (CV) of a "Z" derivative demonstrating a nominal OCP (2.8V) and reversibility



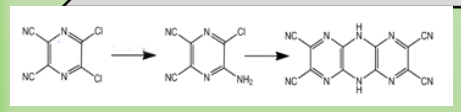
Deconvolution of a "Z" CV trace made by new software using semi-derivatives, allows area testing of reversibility



Linear relationship between Half Reaction currents and Scan Rate, from a "Z" CV trace, further test reversibility

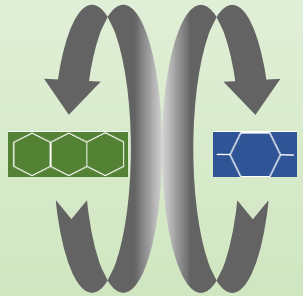


2. Large Scale Synthesis of Precursor "Z" underway



The scale-up of the precursor to the Z derivatives also makes use of newly developed synthetic methodology.

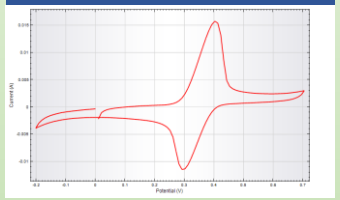
Phase II Progress



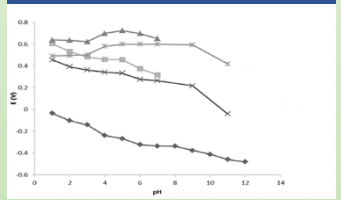
3. Validation Of Bench scale 4W RFB

RFB's involve specific testing techniques that we are developing to evaluate the bench top flow cell test bed at GVSU with organic electrolytes. In preparation for testing of Vinazene electrolytes the cell was tested using Quinone-based electrolytes in aqueous or mixed-organic solvents. Cyclic voltammetry was used to probe the kinetics and reduction potentials were observed as a function of pH, and charge/discharge runs were made in the flow cell.

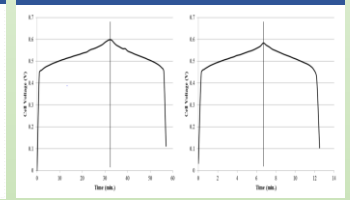
Kinetic and SRP Screening

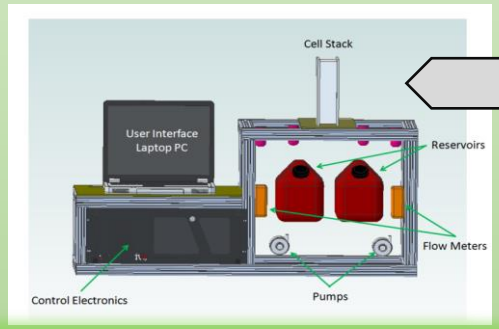


Electrolyte pH Optimization



Charge/Discharge





4. Design and Fabrication of a 40W RFB

Engineering concept of a 40W RFB prototype currently under development. This integrated prototype will demonstrate commercialization readiness for new electrolyte materials.

Acknowledgement and Gratitude for funding and support received from

US Department of Energy
Dr. Imre Gyuk
Energy Storage Systems

Grand Valley State University
Dr. William Schroeder
Dr. Andrew Lantz

Consultants
Jeffery G. Meyer, CE
John Schroeder, EE
Chuck Tanzola

MAREC
Michigan Alternative & Renewable Energy Center

SPARK
Ann Arbor Small Business Accelerator

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